Space Weather Technical Forecast

Issued on Tuesday 10 December 2024 at 01:23 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of M-class flares with a Slight Chance of isolated X-class Flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Low solar activity has been observed in the past 24 hours, with a peak flare of C8.4 at 09/1612 UTC from AR3912.

There are currently six sunspot regions on the disc with the small AR3921 numbered. Further analysis of AR3912 is unlikely due to the lack of high resolution imagery, particularly as it is starting its approach towards the western limb. AR3917 continues to be the most magnetically complex on the Earth-facing disc with its trailing spots appearing to develop more marked penumbra as it rotates westwards. AR3916 appears fairly small and straightforward, with the trailing spots beginning to fade. Other regions appear small and simple at the present time.

No Earth directed CMEs were observed in available imagery.

Solar Wind / Geomagnetic Activity: Solar winds, as recorded at L1 by ACE, showed a connection to a HSS, likely from CH98+. Wind speeds increased from slightly-elevated levels, around 420 km/s, to become slight-elevated to elevated 480-520km/s through much of the period, with a brief maximum wind speed of around 550km/s around 09/0700 UTC. Density has been below average. The Interplanetary Magnetic Field (Bt) was initially moderate at around 10nT but saw a steady reduction from 09/1200UTC, falling to generally weak levels 5-7nT. The north-south component (Bz) has been mainly weakly negative, 5nT to -9nT. The phi angle was positive (away from the Sun) throughout. Quiet to Unsettled geomagnetic activity with an Active interval between 09/0000-09/0300 UTC.

Energetic Particles / Solar Radiation: High energy proton flux observed by GOES18 was at background levels. High energy electron flux (greater than 2MeV) observed by GOES16 was at background levels.

The associated 24-hour fluence was below Active, and the 10/0000 UTC observation 1.14e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: A chance of M-class flares, with a slight chance of isolated X-class flares.

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Solar Wind / Geomagnetic Activity: No Earth directed CMEs are currently expected. Solar wind conditions are expected to remain elevated at times through Day 1 (10 Dec) before an expected reduction in speeds into Day 2 (11 Dec) as the ongoing connection to the HSS from CH98+ looks to become increasingly weak, with solar winds expected to return towards background or slightly elevated levels through the remainder of the period.

Overall Quiet to Unsettled (Kp1-3) geomagnetic conditions are expected through the period, with a likelihood of isolated Active (Kp4) intervals and a slight chance of a G1/Minor Storm through Day 1 (10 Dec) and into Day 2 (11 Dec).

Energetic Particles / Solar Radiation: There is a slight chance of high energy protons reaching the S1/Minor Radiation Storm threshold following any significant flares.

High energy electron flux is expected to be at background or perhaps moderate levels, but the 24-hour fluence is likely to remain below the Active threshold.

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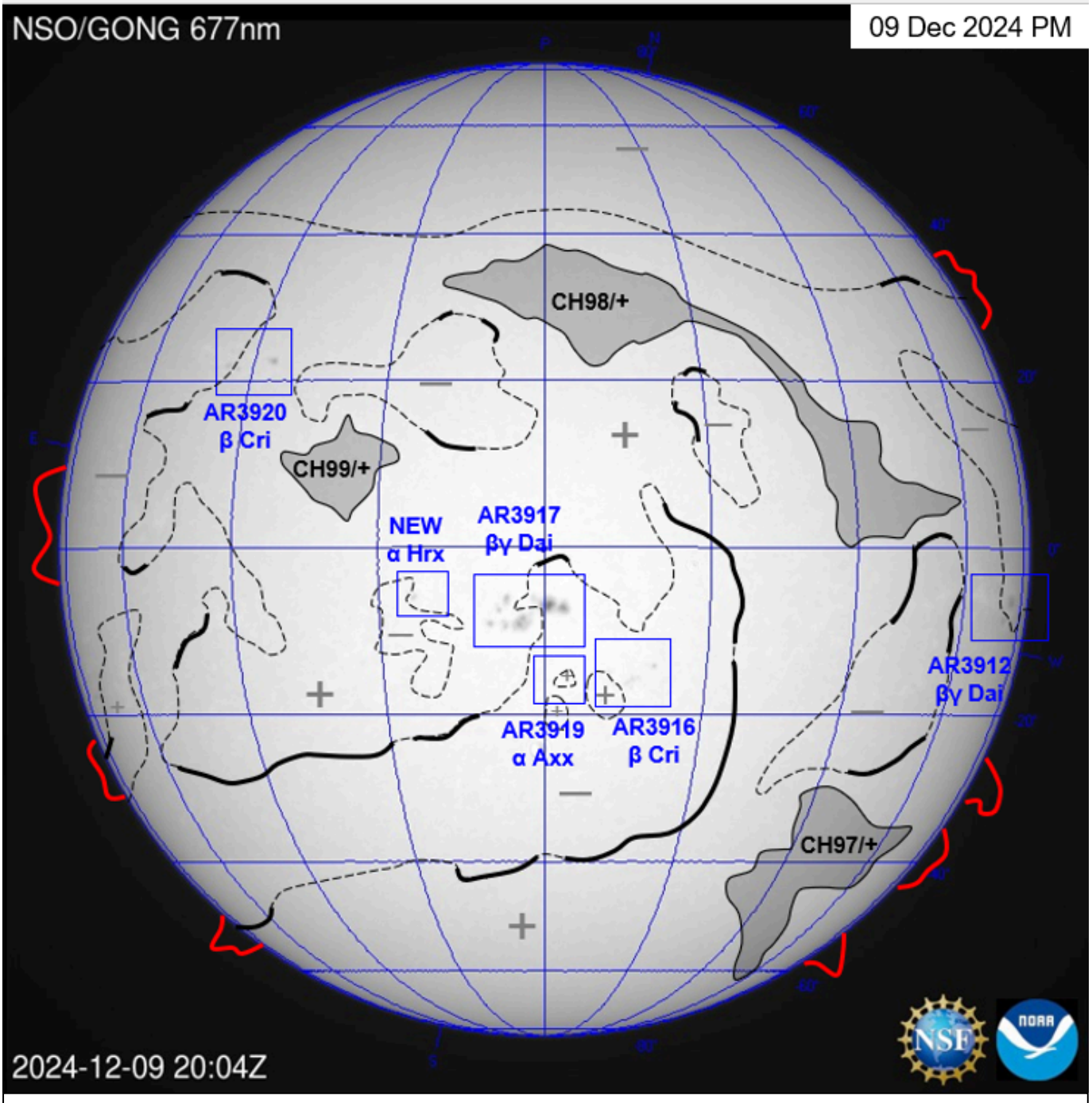
Figure 1: Solar Synoptic Map Valid 09/2000UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

Following on from the X2.2 flare at 08/0906 UTC, analysis suggests that the resulting CME is likely to pass ahead of Earth's orbit, with no or very limited impacts at Earth. No other earth-directed CMEs currently forecast. The large number of significant filaments of the visible disk being closely monitored for any disruption.

The current solar wind parameters at L1 suggest a connection to a high speed stream (HSS) from the southern portion of CH98+. Solar winds are currently sitting between 480-500km/s. Conditions are expected to remain elevated at times through Day 1 (10 Dec) before an expected reduction in speeds into Day 2 (11 Dec) as the connection to the HSS from CH98+ looks to become increasingly weak, with solar winds expected to return towards background or slightly elevated levels through the remainder of the period.

MOSWOCs ENLIL output thought to be providing reasonable guidance into the period, although currently slightly underestimating solar wind strength, and with a further increase in solar wind speed into the 14 Dec viewed as low confidence.

Overall Quiet to Unsettled (Kp1-3) geomagnetic conditions are expected through the period, with a likelihood of isolated Active (Kp4) intervals and a slight chance of a G1/Minor Storm through Day 1 (10 Dec) and into Day 2 (11 Dec).

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	5	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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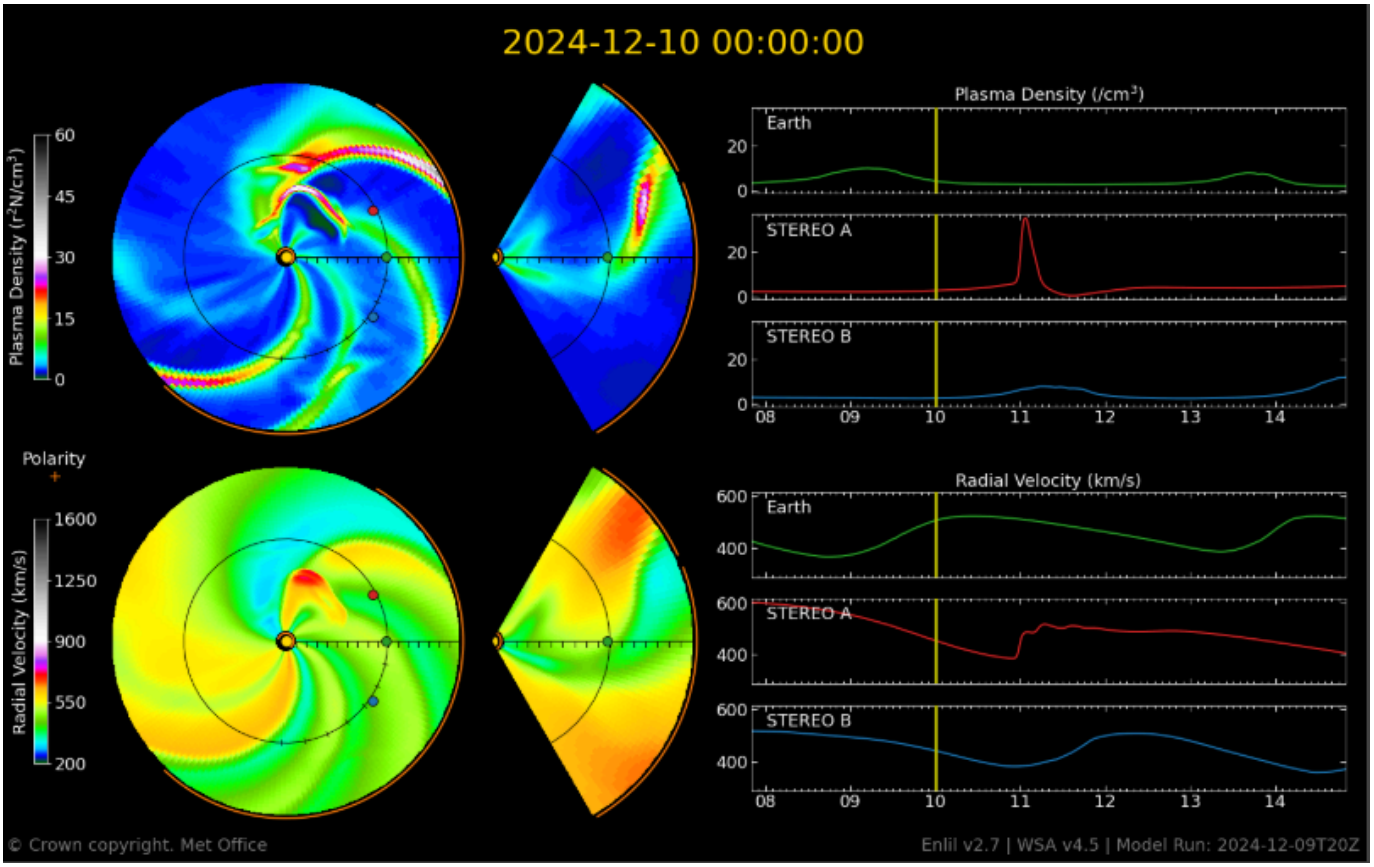
Figure 2: Latest MOSWOC ENLIL output.



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Radio Blackouts - X-Ray Flares

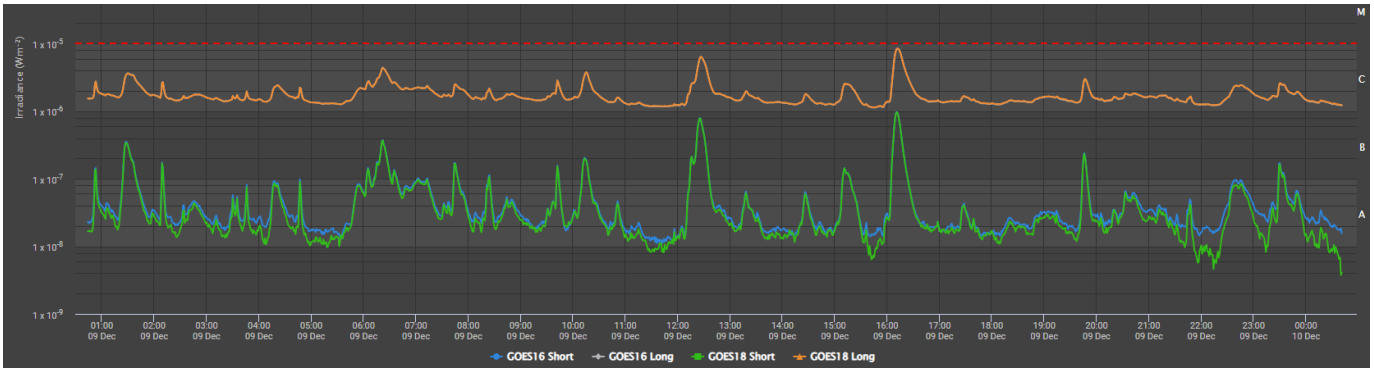
There are currently six sunspot regions on the disc. The most active region in recent days, AR3912 is starting its approach towards the limb with further analysis unlikely due to the lack of high resolution SDO imagery. Given the recent X-flare from this region an ongoing flare risk must be assumed. AR3917 appears the most magnetically complex region on the disc and did show the potential for a delta spot in the leading group, however in recent imagery appears to be simplifying magnetically. AR3916 appears fairly small and straightforward, with the trailing spots beginning to fade. AR3916, AR3917 and AR3919 are all in close proximity to each other, increasing the likelihood of interaction between them. Other regions appear small and simple at the present time.

In terms of oncoming regions, Ex-AR3903 is expected over the southeastern solar horizon inside the next 24 hours - this group produced M-class flares on its last pass. Some looping on the southeast limb suggests the potential for a new region to rotate on in this location, although far side soundings currently not suggesting any significant far-side regions. For departing regions, AR3912, which was responsible for the recent X-flare, will rotate off into Day 2 (11 Dec), with the X-class flare risk tentatively reducing during the following 24 hours pending further developments.

Overall a chance of isolated M-class flares throughout, with a slight chance of further X-class flares maintained. The risk of flares has been increased slightly above raw probabilities due to the history of AR3812, this reducing a little later in the period as AR3912 rotates away.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	No	40	40	40	40
Very Active	R3-R5 (X Class)	No	10	10	5	5

Figure 3: Latest 24hr GOES16/18 X-Ray trace.



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Solar Radiation Storms (High Energy Protons)

GOES18 proton flux is currently at background levels. The previous X2.2 flare from AR3912 did not produce a significant response in the high energy protons, although low energy protons did show a slight rise. Should this region produce another larger flare, then there is a slight chance of a high energy proton response, and this risk remains until AR3912 is well over the limb. Remaining regions on the disc do also contribute a little to this risk, especially as the AR3916/AR3919/AR3917 complex rotates into the western hemisphere.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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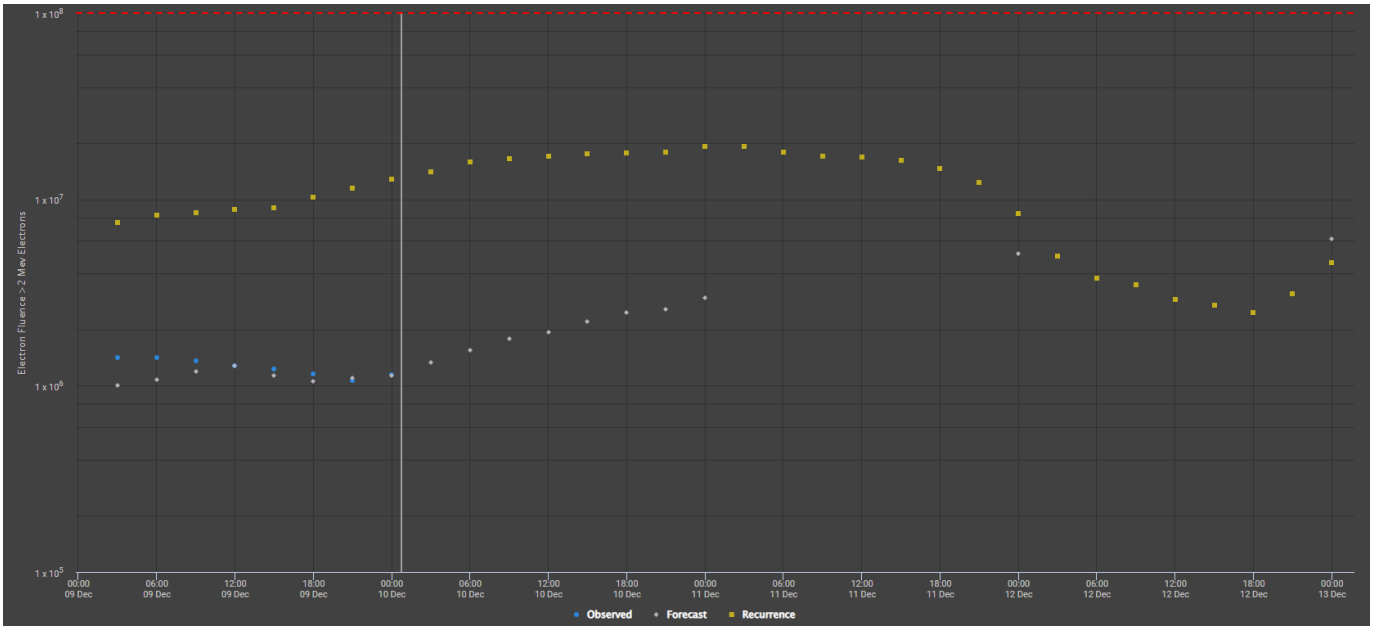
High Energy Electrons (≥ 2MeV)

High energy Electron flux observed by GOES16 has been at background levels. The current high speed stream from the connection to the leading edge of CH98+ may see the electron belt charging, and an increase in electron flux as we move into the forecast period, perhaps a chance of reaching Moderate levels at the diurnal maxima and a slight chance of reaching High levels.

The associated 24-hour fluence is expected to remain below the Active threshold, although a slight increase may occur later in the period. MOSWOC REFM is currently viewed as providing reasonable guidance, showing a flat trend through the next 3 days, which is the most likely outcome.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	1	1	5
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 4: Latest MOSWOC REFM output.



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